Product Specification

Bluetooth v4.0 BLE Single Mode Module

[Generic & AT-command Version]

BL-4011

Version: 1.2

Revision History

Edition #	Reason for revision	Issue Date
1.0	Initial Document	2014/3/6
1.1	Modify Application Circuit	2014/5/6
1.2	Modify Software & Operation Mode	2015/1/30

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Technical Support Contact Information

If you encounter any technical issues while using BL-4011, do not hesitate to contact us @AtechOEM. Our technical staff will help you resolve the technical issues. You can contact us by email or phone. The following is our technical contact:

・Hours:　　　　9:30AM to 5:30PM (GMT+08:00)

・Phone:　　　　+886.2.2377.0282

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1. Overview

BL-4011, Bluetooth low energy (BLE) single mode module is targeted for low power sensors and accessories. It offers GATT profile as the based lower profile. We could also provide other standard BLE profiles such as proximity, find me … etc. The module provides flexible hardware interfaces to connect sensors, simple user interfaces – AT commands.

The single mode radio enables it to connect to the dual mode Bluetooth products already in the market, as well as other Bluetooth low energy devices/ sensors. It can be used in equipments like a heart rate sensors, pedometers, watches, blood pressure meters, weight scales, households sensors, collector devices, security tags, wireless keys, proximity sensors, HID keyboards and mice.

It can be powered directly with 1.8V ~ 3.6V power source, such as a standard 3V coin cell battery. BL-4011 only consumes a little energy in different sleep mode, for example 780nA in lowest power sleep mode.

AtechOEM provides a proprietary GATT-based profile to our customers. The profile is similar to the classic SPP (Serial Port Profile) described in Bluetooth v2.1. Customers could use this special profile to transfer raw data between GATT-based connection in their application. AtechOEM also offer **customized firmware services** to meet specific applications more tightly.

1.1. Model

Following Table shows the different models in BL-4011 series.

BL-4011A	BL-4011E	BL-4011N
Chip antenna on board	U.FL connector	RF Pin Out

2. Typical Applications

- ➢ Home automation
- ➢ Sports & fitness
- ➢ Health care & Consumer wellness
- ➢ Sensors & Controls

- ➢ Industrial automation
- ➢ Security & Proximity
- ➢ Mobile phone accessories
- ➢ Small data transferring

■ **Single Mode Connection Logical Diagram**

Following diagram describes how to use BL-4011 in an application.
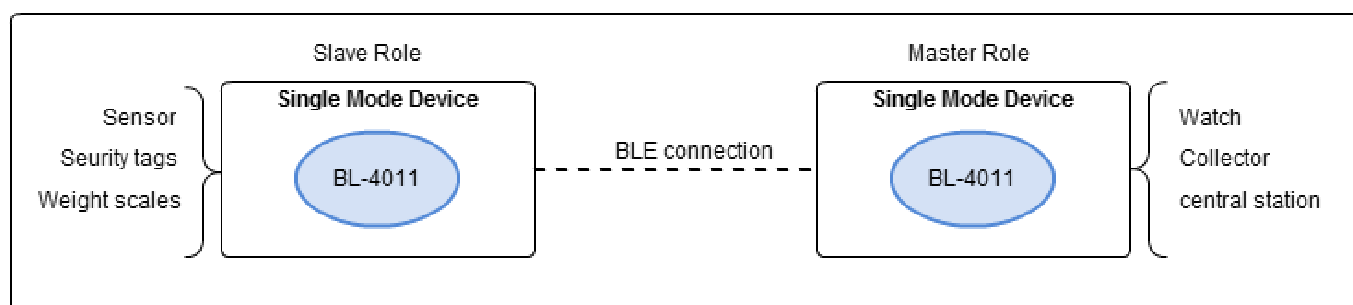
■ **Single/Dual Mode Connection Logical Diagram**

Following diagram describes how to use BL-4011 and other Bluetooth modules in an application.

3. Product Information
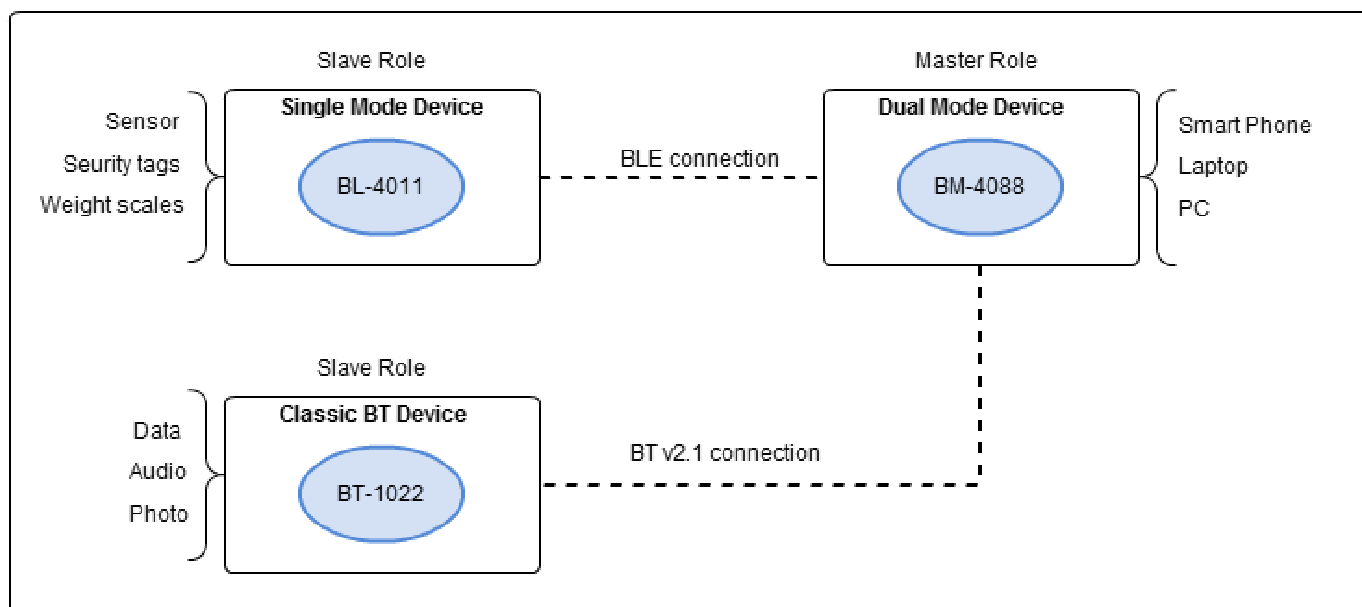
■ Product Number : **BL-4011**

■ Product Description: **Bluetooth v4.0 Single Mode BLE 1010 Module**

■ Product Features:

Chip	CSR1010
Standard	Bluetooth v4.0 Single mode / BLE
EEPROM	256kbits
RF band	2.4~2.4835GHz ISM band
Host Interface	UART
Debug Interface	SPI
Digital Interface	UART / GPIO / I2C
Analog Interface	AIO
RF Output Power	Up to 8.5dBm Typically
Sensitivity	>-93dBm
Antenna	Chip Antenna / U.FL connector / RF Pin Out
Power voltage	1.8 V ~ 3.6V
Dimension	20.7mm x 12.6mm x 1.7mm

4. Hardware

BL-4011 is a surface-mount module designed to be integrated to a system board as a Bluetooth low energy subsystem or standalone system. The power supply ranges from 1.8VDC to 3.6 VDC, so it is suitable for battery application. Digital data (PIO) and analogue interface (AIO) are supported in BL-4011. Following sections describe all hardware specifications and application reference.

4.1. Block Diagram
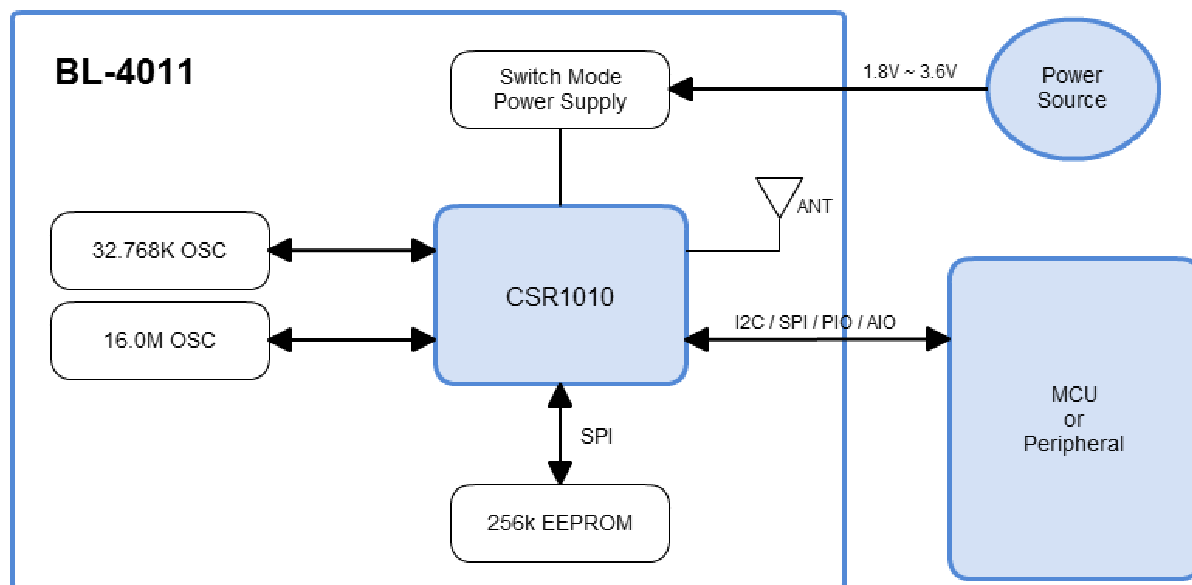
4.2 Pin Assignment

The following picture shows pinouts of BL-4011 from the top of the module.
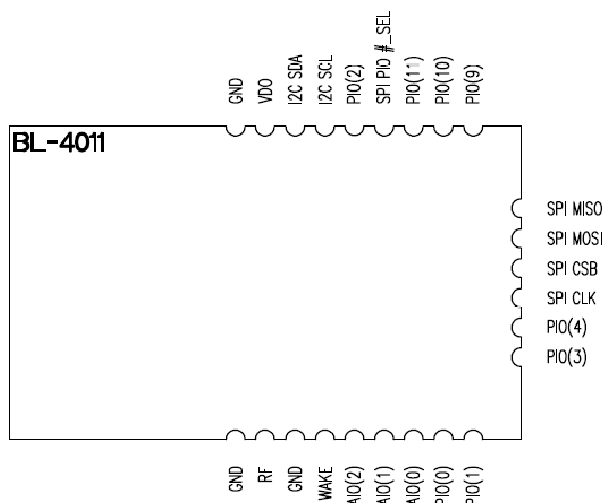
Pin Definition:

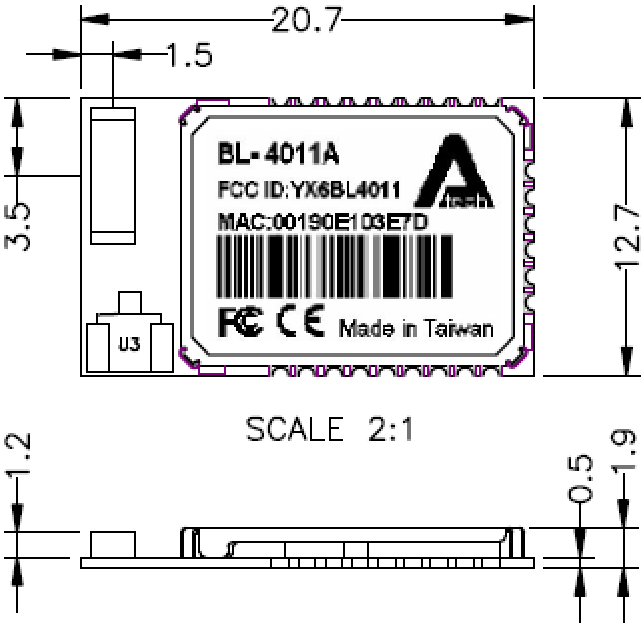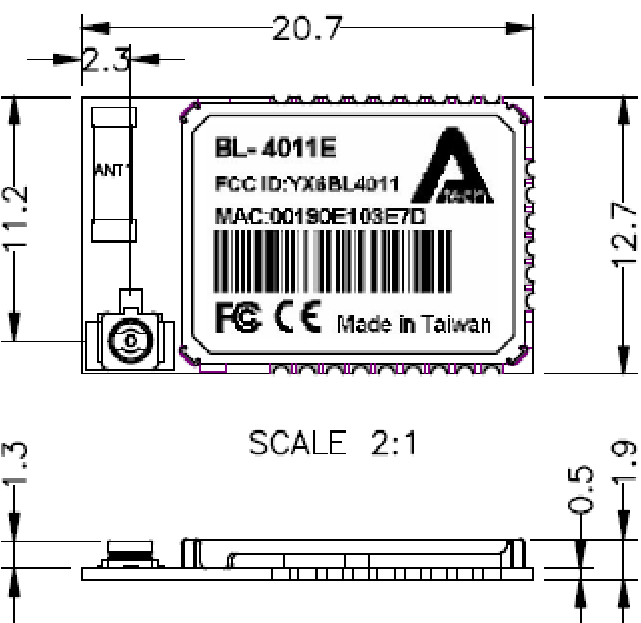| Pin	Name	Type	Note
1	GND	Passive	Ground
2	RF	In/Out	RF Port
3	GND	Passive	Ground
4	WAKE	In	Wake up BL-4011 If in Hibernate or Dormant mode.
5	AIO2	In/Out	Analog I/O
6	AIO1	In/Out	Analog I/O
7	AIO0	In/Out	Analog I/O
8	PIO0 / UART Tx	In/Out	General Purpose I/O
9	PIO1 / UART Rx	In/Out	General Purpose I/O
10	PIO3	In/Out	General Purpose I/O
11	PIO4	In/Out	General Purpose I/O
12	SPI CLK	In/Out	Internal Testing Use
13	SPI CSB	In	Internal Testing Use
14	SPI MOSI	Out	Internal Testing Use
15	SPI MISO	In	Internal Testing Use
16	PIO9	In/Out	General Purpose I/O
17	PIO10	In/Out	General Purpose I/O
18	PIO11	In/Out	General Purpose I/O
19	SPI / PIO # SEL	In	Function Selection
20	PIO2	In/Out	General Purpose I/O
21	I2C SCL	In/Out	I2C Clock In/Out
22	I2C SDA	In/Out	I2C Data In/Out
23	VDD	Power	Main Power Supply
24	GND	Passive	Ground

4.3. Mechanical Specification

BL-4011A	
BL-4011E	

BL-4011N	

4.4. PCB Layout Footprint

4.5. Electrical Characteristics

	Min	Typ.	Max.	Unit
Supply Voltage	1.8	3.3	3.6	V
Normal Standby @ 3.3V	-	1.39	-	mA
TX (Normal mode) @ 3.3V	-	-	22.77	mA
RX (Normal mode) @ 3.3V	-	-	20.88	mA
Shallow Sleep @ 3.3V	-	-	486	uA
Deep Sleep @ 3.3V	-	-	4.9	uA
Hibernate Sleep @ 3.3V	-	-	1.9	uA
Dormant Sleep @ 3.3V	-	-	900	nA

■ Operating Conditions

Voltage Range	1.8V ~ 3.6V
Operating Temperature Range	-30 ^{o}C ~ 85 ^{o}C
Storage Temperature Range	-40 ^{o}C ~ 85 ^{o}C
Relative Humidity (Operating)	≤90%
Relative Humidity (Storage)	≤90%

4.6. Radio Characteristics

	Frequency (GHz)	Min	Typ	Max	BT Spec.	Unit
Tx Output Power (Average)	2.402	-	8.56	-	-20 ~ 10	dBm
	2.440	-	8.99	-		dBm
	2.480	-	8.99	-		dBm
Rx Sensitivity (FER)	2.402	-	-92	-	<=-70	dBm
	2.440	-	-92	-		dBm
	2.480	-	-92	-		dBm
Carrier Frequency Offset	2.402	-	±10	-	±150	kHz
	2.440	-	±10	-		kHz
	2.480	-	±10	-		kHz
Maximum Input Level	2.402		-5		FER <= 30.800 %	dBm
	2.440					
	2.480					
Modulation Characteristics (F1)	2.402	-	253.5	262.5	225 < F1avg < 275	kHz
	2.440	-	260.2	265.3		kHz
	2.480	-	255.9	262.6		kHz
Modulation Characteristics (F2)	2.402	-	225.8	214.3	>= 185	kHz
	2.440	-	228.2	211.4		kHz
	2.480	-	222.7	211.1		kHz
PER Report Integrity	Cycle 1	-	50	-	50.0 <= PER <= 65.4	%
	Cycle 2	-	50	-		%
	Cycle 3	-	50	-		%
Antenna Gain	-	-	0.5	-	-	dBi

4.7. Application Circuit

The thickness of this RF trace should meet 50ohm impedance
Only for RF Feed type use
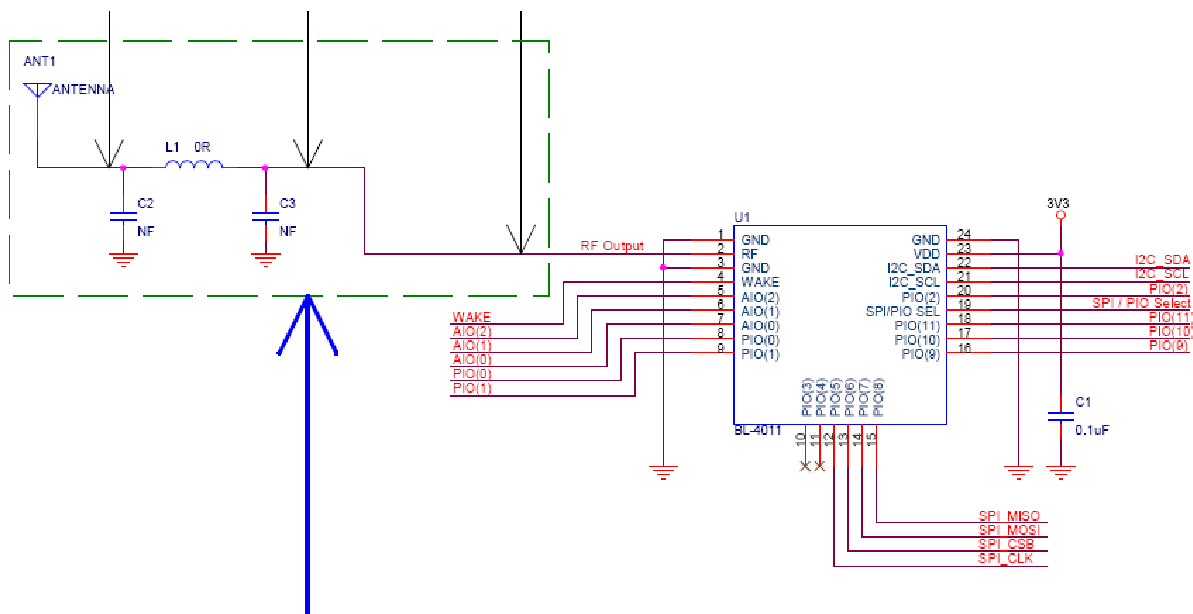
If you use the Chip antenna or Ipex RF type ,
you don't need to place those related components
and route any RF trace .

SPI Debug interface select
High Level : SPI
Low Level : PIO
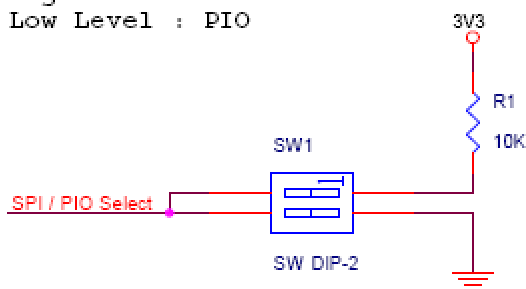
SPI Debug interface
PIO(5) -> SPI CLK
PIO(6) -> SPI CSB
PIO(7) -> SPI MOSI
PIO(9) -> SPI MISO

UART intrerface :
PIO(0) -> UART TXD
PIO(1) -> UART RXD
PIO(9) -> UART RTS
PIO(10) -> UART CTS
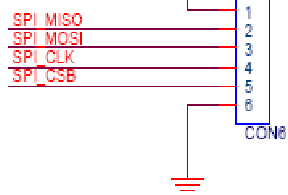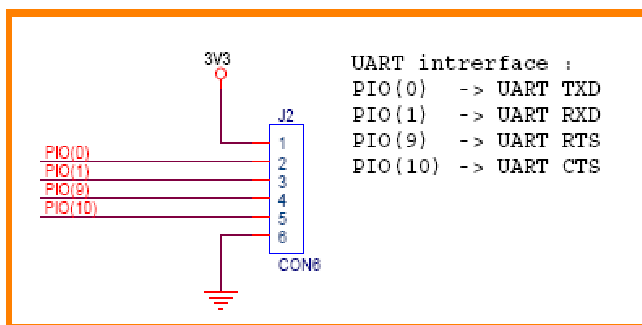
Application for Linear LDO use

U2
RT9170-33GV
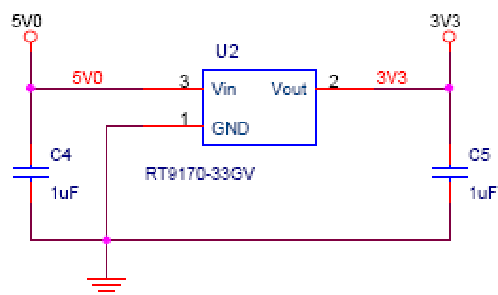
Note :
Richtek RT9170 : Maxima output current 300mA

Signal & Function

WAKE : Wake up the system from sleep or sniff mode
AIO[0-2] : Analog signal In and Output
PIO : Programble In/Out
I2C : Inter-Integrated Circuit

5. Software & Operation Mode: Data-Transfer Application

The special firmware in BL-4011 supports two different operation modes: **Client mode** and **Server mode**. This special firmware allows BL-4011 to transfer data through the UART interface, which is similar to the **SPP profile** in Bluetooth v2.1 standard.

BL-4011 with Client-mode firmware can initiate the connecting process between client and server. With Server-mode firmware, BL-4011 can advertise its information and wait for the client's connecting.

AtechOEM also can provide standard GATT-based profiles issued in Bluetooth SIG. We also provide customized firmware to our customers to apply to different applications.

5.1. Application Architecture with Client-mode and Server-mode

Application architecture of BL-4011 with Client and Server mode is showed as below. The Client-mode also can be connected by an smart phone based on GATT connection. The data can be transferred through an UART interface or an APP on a smart phone.
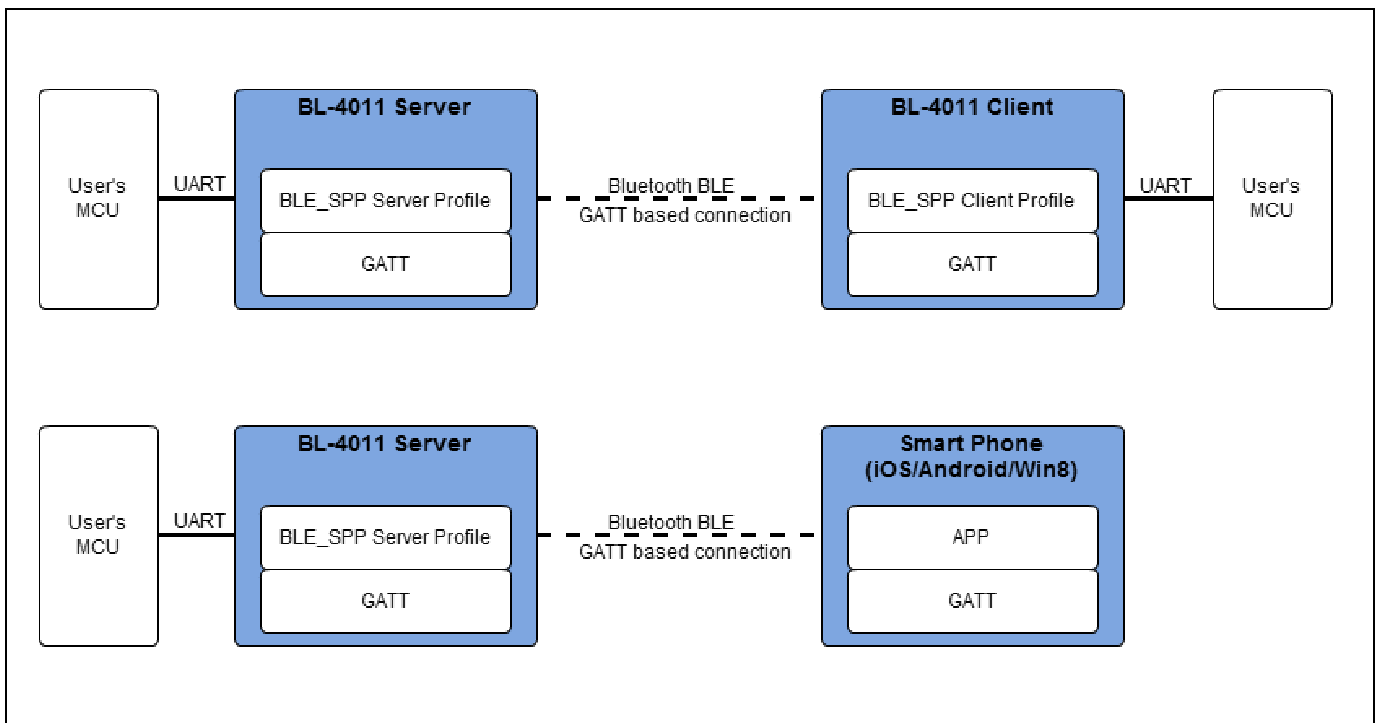
5.2. SPP Connection Example in AT-command mode

The following example describes simple connecting process between client and server mode in BL-4011.
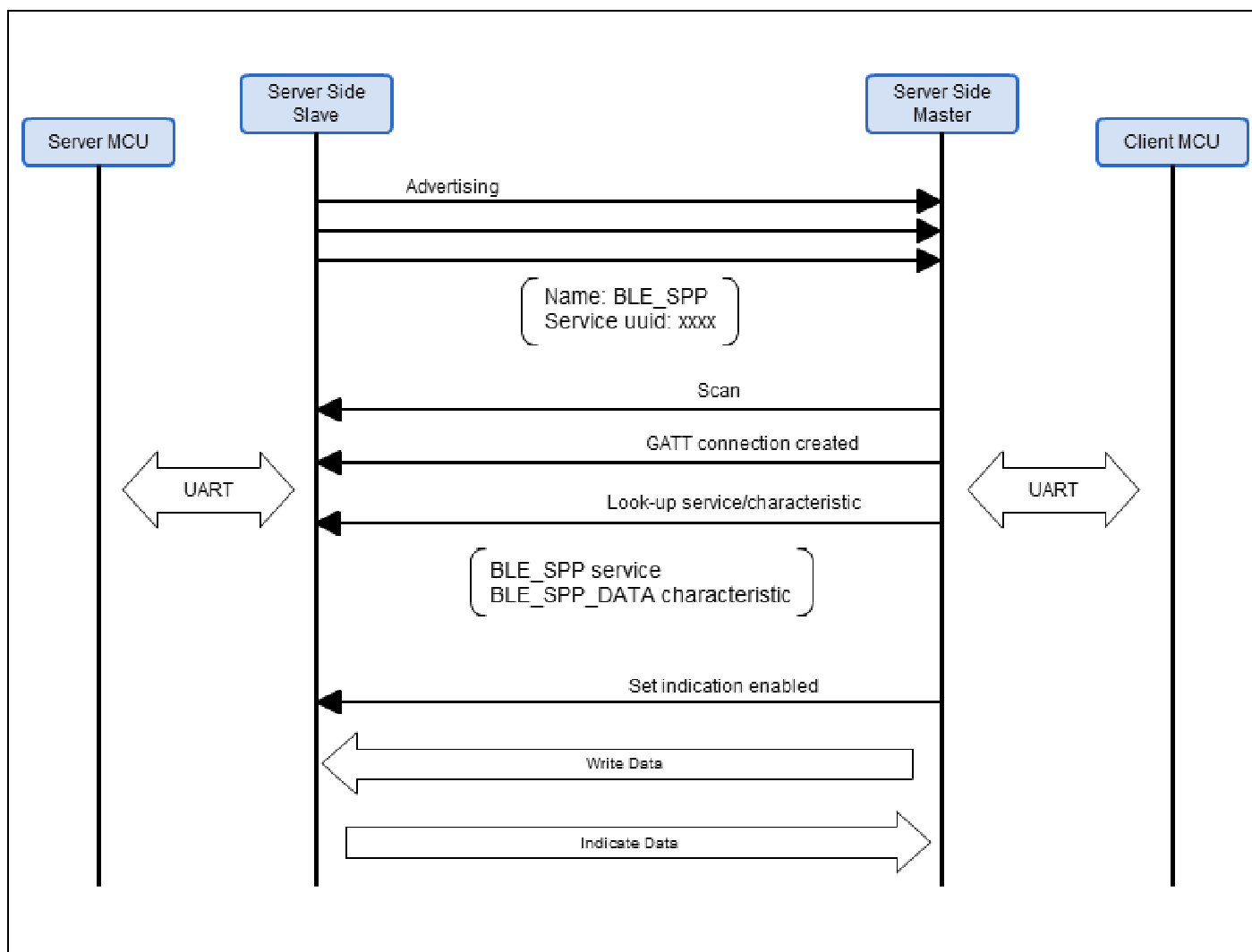
5.3. Configuration in Server Mode

■ **Default Configurations in Server Mode:**

Bluetooth		UART	
Profile	GATT / BLE_SPP (Private)	Baud Rate	2400 bps
Device Name	BLE_SPP	Data Bits	8
BLE_SPP Service UUID	0x3a1bc6e0fb0611e1b9c20002a5d5c51b	Parity	No
BLE_SPP_DATA characteristic UUID	0xcc330a40fb0911e1a84d0002a5d5c51b	Stop Bits	1
BLE SPP RemoteIO Characteristic UUID	0xd2127900f28e11e2b7780800200c9a66		

■ **Hardware configuration:**

PIO	Description		
	Name	Direction	States
3	PIO3	Output	State controlled by remote device. Output state is low state after boot.
4	PIO4	Output	
9	PIO9	Output	
10	State Button	Input	Low state less than 4 second: change state. (reference to state button configuration table described at below) Low state more than 4 second: reset default
11	Link LED	Output	High: LED On Low: LED Off

■ **LED Status:**

Status	Descriptions
Link LED steadily on	Connection established.
Link LED blinking	Server role: Device is advertising. Client role: Device is scanning.
Link LED off	No power supply or device is idle.

■ **State button configuration:**

Client Role		
Original State	New State	Description
Idle	Connecting	Connect to the device specified by "DEVICE= ".
Scanning	Idle	Abort scanning and return to idle state.

Connecting	Idle	Abort connecting and return to idle state.
Connected	Idle	Disconnect and return to idle state.

Server Role		
Original State	**New State**	**Description**
Idle	Advertising	Start advertising
Advertising	Idle	Abort advertising and return to idle state.
Connected	Idle	Disconnect and return to idle state.

Notice

The adaptor operates at either command mode or data mode.

The adaptor only accepts commands at command mode, and only transmits data at data mode. The adaptor could receive data whether its operational mode is command mode or data mode while the adaptor has connected with another device.

The adaptor always operates at command mode after boot.

The operational mode will *NOT* be changed whether two devices has been connect or disconnect. User should be changing it manually.

5.4. AT Command Specification

Setup Command Set (capital letter or lowercase letter is allowed)

Command	Value	Description
+++		Set the local adaptor change the data mode into command mode. The time interval between character will be more than the time: [1 sec] +++ [1 sec] This command should *NOT* include the terminal characters "\r" or "\n".
All command listed at below should include the terminal character "\r\n"		
EXIT		Put the local adaptor into data mode.
ADDRESS=		
	?	Inquire the Bluetooth Address of the local adaptor.
ADVERT=		This command is used to start advertising. This command is available only when the adaptor is in the server role. Reponse "End advertising process" if the advertising time out and without any connection.
	Y	Start advertising
	N	Stop advertising
AT		Check the connection status between control terminal and the local adapter. Response: "OK" when the connection is ok.
AUTOADV=		This command is used to enable/disable auto-advertising feature. It is available only when the adaptor is in the server role.
	Y	The server role adapter will automatically enter advertising state.
	N	The server role adapter will NOT automatically enter advertising state.
BAUD=		This command is used to specify the baud rate of COM port.
(Default)	2400	2400 bps
	4800	4800 bps
	9600	9600 bps
	19200	19200 bps
	38400	38400 bps
	57600	57600 bps
	115200	115200 bps
	R	Restore the default settings. (Baud rate =2400 bps)
	?	Inquire the current baud rate.
CONNECT=		This command is used to establish a connection manually. It is available only when the adaptor is in the client role.
	1~8	Connect the adaptor to a Bluetooth device in the neighborhood found through "SCAN=?"
	?	Display the MAC address of the latest connected device.
	P	Connect to the device specified by "DEVICE= ".
	N	Disconnect the two adapters in the command mode.
DEFAULT=		This command is used to restore the default settings and originate a warm start.

	Y	Restore the default settings. The command will re-start the system for 1 second.
DEVICE=		Specify device is a top priority device when the client device trying to connect. This command is only avaiable when auto-connection.
	Xxxxxxxxxxxx	"xxxxxxxxxxxx" is a string of 12 hexadecimal digits.
	R	Clear the specify device content.
	?	Inquiry the designated address that can be paired and connected.
AUTOPAIR=		This command is used to enable/disable auto-pair feature.
	Y	Start the aotu-pair process.
NAME=		This command is used to specify a name for the adaptor.
	xx…xx	"xx….xx" is a character string with the length from 2 to 20.
	R	Restore the default settings name="BLE SPP"
	?	Inquire the name of the local adaptor.
PARITY=		This command is used to specify parity bit setting of COM port.
(Default)	N	None parity bit
	O	Odd parity bit
	E	Even parity bit
	?	Inquire the current setting.
PIO[para]=		This command is used to set remote pio output state. [para] is the number of PIO interested to control.
	H	Set remote PIO output high state.
	L	Set remote PIO output low state.
PROMPT=		The command is used to decide whether result messages are prompted when Setup commands are executed. The result messages are: OK/ERROR for command execution, or CONNECT/DISCONNECT/Try Connect Device for connection status.
	N	Not prompt result messages.
(Default)	Y	Prompt result messages.
	?	Inquire the current setting.
ROLE=		This command is used to specify whether the adaptor is in the master or slave role. If the device role is changed, the adaptor will reboot.
	C	Set the adaptor to the client role.
(Default)	S	Set the adaptor to the server role.
	?	Inquire the current role of the adaptor.
RESET=		
	Y	Reboot the adaptor.
RSSI=		Received signal strength indication
	?	Display the Received signal strength indication in command mode when connected.
SCAN=		This command is used to search for any Bluetooth device which supported Atech-SPP service in the neighborhood within 10 sec. If any device is found, its name and its 12-digit-address will be listed. The search ends with a message "Inquiry ends. xx device(s) found." This command is available

		only when the adaptor is in the client role by manual.
	?	Inquire Bluetooth devices in the neighborhood, listing 8 devices the maximum.
STATUS=		Inquire all the current setting of the adapter.
	?	Display all the current setting of the adapter
STOP=		This command is used to specify one or two stop bits of COM port.
(Default)	1	One stop bit.
	2	Two stop bits.
	?	Inquire the current setting.
VERSION=		This command is used to inquiry the firmware version.
	?	Inquire the version codes.

Federal Communication Commission Interference Statement

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation.

This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:
. Reorient or relocate the receiving antenna.
. Increase the separation between the equipment and receiver.
. Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
. Consult the dealer or an experienced radio/TV technician for help.

FCC Caution: To assure continued compliance, any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment. (Example - use only shielded interface cables when connecting to computer or peripheral devices).

End Product Labeling

This transmitter module is authorized only for use in devices where the antenna may be installed such that 20 cm may be maintained between the antenna and users. The final end product must be labeled in visible area with the following: "Contains FCC ID: YX6BL4011"

End Product Manual Information

The user manual for end users must include the following information in a prominent location "IMPORTANT NOTE: To comply with FCC RF exposure compliance requirements, the antenna used for this transmitter must be installed to provide a separation distance of at least 20cm from all persons and must not be colocated or operating in conjunction with any other antenna or transmitter."   This device complies with part 15 of the FCC rules. Operation is subject to the following two conditions   (1) This device may not cause harmful interference and   (2) This device must accept any interference received, including interference that may cause undesired operation.

IMPORTANT NOTE: In the event that these conditions can not be met (for example certain laptop configurations or colocation with another transmitter), then the FCC authorization is no longer considered valid and the FCC ID can not be used on the final product. In these circumstances, the OEM integrator will be responsible for reevaluating the end product (including the transmitter) and obtaining a separate FCC authorization.   This device is intended only for OEM integrators under the following conditions: The antenna must be installed such that 20 cm is maintained between the antenna and users. As long as a condition above is met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end product for any   additional compliance requirements required with this module installed   (for example, digital device emissions, PC peripheral requirements, etc.).